



**Western Regional Air Partnership (WRAP)
Regional Modeling Center (RMC)**

**Monthly Progress Report
for November 2005**

Prepared by

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Introduction

This is the November 2005 Monthly Progress Report that covers the activities of the Western Regional Air Partnership (WRAP) Regional Modeling Center (RMC).

Background

The WRAP RMC is composed of staff from the University of California, Riverside (UCR), ENVIRON International Corporation, and the University of North Carolina's Carolina Environmental Program (UNC-CEP). The Principal Investigator and Project Manager for the RMC is Dr. Gail Tonnesen of UCR (tonnesen@cert.ucr.edu). Mr. Ralph Morris (rmorris@environcorp.com) and Mr. Zac Adelman (zac@unc.edu) lead the RMC efforts at ENVIRON and UNC-CEP, respectively. The RMC is the contractor for meteorological, emissions, and air quality modeling and analysis performed for the WRAP region's states and tribes to provide the analytical results needed to address the requirements of the EPA Regional Haze Rule.

Current responsibilities of the RMC include:

- Emissions processing and modeling
- Air quality and visibility modeling simulations
- Analysis, display, and reporting of modeling results
- Storage and quality assurance of the modeling input and output files

The tasks and deliverables discussed in this report are based on the WRAP RMC 2005-06 work plan, which is available on the WRAP RMC web site:

<http://pah.cert.ucr.edu/aqm/308/docs.shtml>

The tasks are linked to and based on the WRAP Strategic Plan and the WRAP 2005 Work Plan, found at:

http://wrapair.org/WRAP/meetings/031014board/Tab_4_Strategic_Plan_Final.pdf

http://wrapair.org/WRAP/documents/041207WRAP_CY05_Final_Workplan.pdf

The WRAP Technical Coordinator (Tom Moore) and the cochairs of the WRAP Modeling Forum (John Vimont of the National Park Service, Mary Uhl of the New Mexico Environment Department, and Kevin Briggs of the Colorado Department of Public Health and Environment) provide day-to-day oversight of RMC activities, and the Modeling Forum oversees the activities of the RMC through monthly conference calls, topical conference calls, and periodic in-person meetings and workshops.

The WRAP is one of five Regional Planning Organizations (RPOs) consisting of states, tribes, federal and local agencies, and stakeholders charged with the responsibility for conducting technical analyses and assisting in the development of State Implementation Plans (SIPs) and Tribal Implementation Plans (TIPs) for regional haze in different areas of the United States.

Overview of WRAP RMC 2005-06 Work Effort

The WRAP RMC 2005-06 work effort is focused on the following activities (please refer to the 2005-06 work plan for background information):

- 1) Finalize the 2002 base case input data and the selection of models to be used for future-year 2018 modeling.
- 2) Implement final performance metrics, displays, and methods to project future-year model results.
- 3) Complete and analyze a 2018 base case modeling scenario.
- 4) Complete and analyze several emissions reduction and emissions sensitivity scenarios.
- 5) Perform additional source apportionment model simulations.
- 6) Complete the visibility modeling effort for Alaska.

The overall objective of the 2005-06 work plan is to complete all modeling studies and documentation needed for development of §308 SIPs and TIPs for regional haze. The WRAP visibility modeling system comprises the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions model, the Fifth-Generation Mesoscale Model (MM5) meteorological model, and the Community Multiscale Air Quality (CMAQ) model. The WRAP modeling domain consists of a continental U.S. 36-km domain and a western U.S. 12-km domain. The WRAP RMC modeling efforts also include analysis of specific topics to support the other WRAP forums. The RMC's 2005-06 work effort as laid out in the work plan is divided into 12 tasks, listed below. Note that Task 3 is not covered in this report because it was essentially completed by the end of project year 2004.

- Task 1: Project Administration, Major Project Reports, and Computer Hardware and Systems Administration
- Task 2: Emissions Modeling, Processing, and Analysis
- Task 3: Test, Improve, Quality Control, Obtain External Peer Review, and Finalize 36-km and 12-km MM5 Simulations for Eventual Use in CMAQ (*completed in project year 2004*)
- Task 4: Air Quality Model Evaluation for 2002 Annual Simulation
- Task 5: Testing and Further Improvements to the Windblown Dust Emissions Modeling Methodology
- Task 6: BART Source Sensitivity Screening Using CALPUFF
- Task 7: Sensitivity Studies Designed to Evaluate Uncertainties in Fire Emissions

- Task 8: Preliminary Meteorological, Emissions, and Air Quality Modeling Activities for Alaska
- Task 9: Further Analysis of Model Performance in Regard to the Contribution of Natural Emissions to Visibility Impairment
- Task 10: Preparation and Reporting of Geographic Source Apportionment Results
- Task 11: Technology Transfer
- Task 12: Computer Hardware

Highlights for the November 2005 Reporting Period

- *Task 1—Project Administration, Major Project Reports, and Computer Hardware and Systems Administration:* We held several conference calls to revise the work plan and to refine plans for the emissions and air quality modeling. We participated in the Attribution of Haze workgroup meeting in Phoenix, AZ, on November 17.
- *Task 2—Emissions Modeling, Processing, and Analysis:* We continued the data collection for and began modeling the planning 2002 (Plan02a) annual simulation for CMAQ. We also initiated the data collection and modeling effort for the first base 2018 (Base18a) annual simulation. We converted the base 2002 (Base02a) annual emissions to CAMx format. We also prepared emissions for a fire sensitivity simulation to study the effects of small wildfires. After discovering several problems with the fire sensitivity emissions and CAMx conversions, we made corrections to these data and regenerated the air quality model input files. We also worked with ERG, Inc. to create typical electricity generation unit (EGU) temporal profiles for the stationary point sources and to review the stack parameters that are applied to the latest Mexican point-source inventory.
- *Task 4—Air Quality Model Evaluation for 2002 Annual Simulation:* We completed the 2002 Final 12-km model simulation and model performance evaluation. We posted all results to the project web site (<http://pah.cert.ucr.edu/aqm/308/cmaq.shtml#base02aV4512kvs36k>), and we presented the evaluation results on the November Modeling Forum conference call.
- *Task 5—Testing and Further Improvements to the Windblown Dust Emissions Modeling Methodology:* We presented a summary of the task and its results at the Dust Emissions Joint Forum meeting held in Tempe, AZ, on November 15-16.
- *Task 6—BART Source Sensitivity Screening Using CALPUFF:* The RMC is developing a BART modeling protocol with Tom Moore of WRAP.
- *Task 7—Sensitivity Studies Designed to Evaluate Uncertainties in Fire Emissions:* We performed several fire sensitivity simulations on the CMAQ 12-km domain, but later discovered an error in the emissions processing for these cases, so they will be repeated in December.

- *Task 8—Preliminary Meteorological, Emissions, and Air Quality Modeling Activities for Alaska:* CALPUFF analysis continues to be evaluated and will be used in the Task 6 BART modeling.
- *Task 10—Preparation and Reporting of Geographic Source Apportionment Results:* We continued to discuss the setup of the source apportionment modeling with WRAP. We revised the work plan to perform the annual CAMx/PSAT simulation using the planning scenarios instead of the 2002 version A model performance evaluation scenario. We are continuing to perform benchmarks on the PSAT code to prepare for these simulations when the Planning Case 2002 emissions are ready.
- *Task 12—Computer Hardware:* We installed two new RAID5 disk storage systems that increase our data storage capacity by 8 TB.

November 2005 RMC Status Report

Below we discuss our progress during this monthly reporting period (November 2005) and expected activities during the next reporting period (December 2005). We also describe any difficulties encountered and their resolutions.

Task 1: Project Administration, Major Project Reports, and Computer Hardware and Systems Administration

Purpose:

Within Task 1, the project administration subtask includes deliverables tracking and display, coordination with modeling efforts supported by other RPOs, attending meetings, participating in conference calls, and general project management. The major project reports subtask covers preparation of four reports: the 2004 final report, the 2002 model performance report, the 2018 base case modeling report, and the RMC 2005-06 project final report. The computer hardware and systems administration subtask includes maintenance, updates, expansion, and optimization of the computing systems (software and hardware updates, maintenance of the project web site and listservs, and data backups and archiving).

Progress During This Reporting Period:

Project Administration:

UCR, ENVIRON, and UNC-CEP participated in monthly project administration and WRAP Modeling Forum conference calls. Each contractor also contributed to the monthly progress report and prepared invoices. During November we held several additional conference calls with the WRAP Modeling Forum to revise the work plan and to refine plans for the emissions and air quality modeling. We also participated in the Attribution of Haze workgroup meeting in Phoenix, AZ, on November 17.

Major Project Reports:

We finalized the content and scope for the final report on the 2002 model performance evaluation, and revised the report preparation schedule. We removed from the outline the chapter on the fire sensitivity simulations; these will instead be discussed in a separate report in January 2006. The sections on the CAMx results and comparison with CMAQ will be completed by December 19. Drafts of all other sections are due to the RMC technical editor on December 12. A final draft will be completed by the end of 2005.

Computer Hardware and Systems Administration:

Hardware activities are discussed under Task 12.

Expected Progress During the Next Reporting Period:

We will conduct the December Modeling Forum and project management calls, prepare the November progress report, and complete the draft chapters for the 2002 model performance evaluation report.

Difficulties Encountered and Resolutions:

None.

Task 2: Emissions Modeling, Processing, and Analysis

Purpose:

To develop final emissions inventories for the 2002 model performance evaluation case, a typical 2002 case, a 2018 base case, and several 2018 emissions control strategy cases.

Progress During This Reporting Period:

Technical Activities:

Our primary focus in November was to begin the modeling and QA of the data for the Planning 2002 annual simulation (Plan02a). Simulation Plan02a is built from the first iteration of the base 2002 emissions (Base02a), with corrections to several emissions sectors in the WRAP and VISTAS states. Simulation Plan02a also includes updated emissions for Mexico and for commercial shipping in the Pacific. Listed below are all of the emissions updates in simulation Plan02a:

- *Stationary area:* Revisions to California, Washington, North Dakota, Oregon, and Utah inventories; updates to the VISTAS inventory (VISTAS Base F); inclusion of a new inventory for the six northern Mexican states
- *WRAP fires:* Typical-year fires replace actual 2002 fires
- *Fugitive dust:* Revisions to California, Washington, North Dakota, Oregon, and Utah inventories; updates to the VISTAS inventory (VISTAS Base F); inclusion of a new inventory for the six northern Mexican states
- *On-road mobile:* Revisions to California and Montana inventories; inclusion of a new inventory for the six northern Mexican states

- *Non-road mobile*: Revisions to the California inventory; updates to the VISTAS inventory (VISTAS Base F); inclusion of a new inventory for the six northern Mexican states
- *Oil and gas*: Revisions to the California inventory
- *Stationary point*: Revisions to the California, Arizona, Montana, New Mexico, Oregon, Utah, Washington, and Wyoming inventories; revisions to the WRAP tribal land inventory; updates to the VISTAS inventory (VISTAS Base F); inclusion of a new inventory for the six northern Mexican states; updated EGU temporal profiles for WRAP sources
- *Road dust*: Revisions to the California inventory; updates to the VISTAS inventory (VISTAS Base F)
- *Commercial marine*: Updates to shipping in the Pacific and California in- and near-shore inventories

Additional work related to the Plan02a simulation included the creation of new spatial surrogates to model Bloomfield County, CO, and several updates to the temporal allocation data provided by other RPOs, particularly VISTAS. In addition to the modeling and QA for simulation Plan02a, we also began data collection for the first iteration of an annual 2018 simulation (Base18a). While we have not yet started the modeling of these data, we are in the process of configuring SMOKE, applying growth and control factors to project some of the data from 2002 to 2018, and preparing for the annual simulations to begin in early December. We have targeted December 23 as the completion date for the Plan02a and Base18a simulations.

We also converted Base02a processed emissions to CAMx inputs. We used SMOKE to generate model-ready netCDF files and the CAMx converter to generate low- and elevated-level emissions for CAMx. We combined all of the area-like emissions (stationary area, road dust, ammonia, nonroad and on-road mobile) and converted them to CAMx input format using SMOKE. For the point-source and offshore-point-source emissions, we processed them through SMOKE to generate CAMx-formatted inputs. We used a program supplied by ENVIRON to merge all the CAMx low-level emission input files to one file and all of the elevated-level emissions into a second file.

To prepare inputs for the fire sensitivity scenario, we removed a selected group of small wildfire events from the total fire inventory. We received the list of events from Air Sciences to remove from the base02a inventory. We then processed the new fire inventory, without small wildfires, and merged with the rest of the emission categories to generate CMAQ inputs for the months of July and November.

Preparation of the 2002 Model Performance Report, 2018 Base Case Modeling Report, and 2005-06 Project Report:

We generated one additional version of the 2005-06 emissions modeling work plan that explicitly defines the various emissions simulations and their accompanying datasets for the Plan02a and Base18a simulations. We began preparing emissions QA and summary graphics to include in the 2002 model performance evaluation report. We also continued QA on the model-ready emissions for both the WRAP and non-WRAP portions of the modeling domain for which we

already have emissions inventories. The products of this QA work will be added to the 2002 model performance report.

Expected Progress During the Next Reporting Period:

We plan to complete the modeling and QA work for the 2002 Plan02a and Base18a simulations in December. We will also complete a draft version of the 2002 model performance evaluation report.

Difficulties Encountered and Resolutions:

We discovered errors in the preparation of the emissions for the fire sensitivity simulations; details of these errors and corrections are provided in the write-up for Task 7. We also discovered problems in the conversion of the CMAQ-ready emissions to CAMx format. One problem was related to a units conversion, the other to formatting problems with the converted files. We corrected the units conversion by changing the CAMx emissions files from units of moles/second to moles/hour. We corrected the formatting problem by re-creating the emissions with an updated version of SMOKE.

Task 4: Air Quality Model Evaluation for 2002 Annual Simulation

Purpose:

To complete the 2002 base-year air quality modeling performed with CMAQ and CAMx, 2000-2004 typical-year modeling, 2018 base case modeling, and a series of 2018 control strategy modeling runs. Also, to perform model bug fixes, model version updates, and sensitivity experiments.

Progress During This Reporting Period:

Technical Activities:

We completed the annual 12-km CMAQ simulation with the final emissions inventory (Base02a) and compared these results to the CMAQ 36-km results. We posted all results to the project web site (see <http://pah.cert.ucr.edu/aqm/308/cmaq.shtml#base02aV4512kvs36k>), and we presented the evaluation results on the November Modeling Forum conference call. The evaluation products include those plots and performance metrics that we have found to be most useful during the past three years of visibility, including the following:

- Monthly-average model performance metrics
- Bugle plots (grouped both by species and by monitoring network)
- Animated spatial plots with data overlaid on the model predictions
- Stacked-bar time-series plots for each site
- Stacked-bar plots for the best and worst average 20% days at each site using (1) matched in space and time, (2) relaxed in time, and (3) relaxed in both space and time.

Initial simulations for CAMx were completed for the months of February and July. These were designed as QA tests at ENVIRON, with the annual CAMx simulation to be completed subse-

quently at UCR. However, there were errors in the preparation of the CAMx emissions files, so the results of the CAMx two-month simulations were not useful for comparison with CMAQ results. It required a couple weeks of effort to debug and reprocess the conversion of CMAQ emissions to CAMx emissions files. This was completed at the end of November, and the annual CAMx 36-km simulation will be completed in December.

Preparation of the 2002 Model Performance Report, 2018 Base Case Modeling Report, and 2005-06 Project Report:
None.

Expected Progress During the Next Reporting Period:

We will complete the CAMx annual 36-km model performance evaluation by preparing a variety of model performance analyses, including the following: monthly average bias and error plots; bugle plots; annual stacked-bar plots at each site; and stacked-bar plots of average model performance at each site for the best and worst average 20% days. We will begin the CAMx/PSAT simulation when the planning case emissions are completed.

Difficulties Encountered and Resolutions:

There were problems with the codes used to convert the CMAQ emissions to the CAMx emissions. New codes and scripts were developed, and we prepared new emissions files for CAMx.

Task 5: Testing and Further Improvements to the Windblown Dust Emissions Modeling Methodology

Purpose:

To implement further improvements to the windblown dust emissions modeling methodology, and to test the effect of alternative schemes in CMAQ. (This is an optional task that is a follow-on to the 2004 task covering the same topic, and will be implemented only if we are directed to do so by the WRAP Dust Emissions Joint Forum.)

Progress During This Reporting Period:

Technical Activities:

We presented a summary of the task and its results at the Dust Emissions Joint Forum meeting held in Tempe, AZ, on November 15-16.

Preparation of the 2002 Model Performance Report and 2005-06 Project Report:
None.

Expected Progress During the Next Reporting Period:

The windblown dust emissions model task report will be revised to discuss the updates to the model. CMAQ modeling runs and analyses will be performed using the new dust estimates. We will implement the new results and address the comments on the revised draft task report. Improvements to the methodologies will be incorporated as appropriate.

Difficulties Encountered and Resolutions:

None.

Task 6: BART Source Sensitivity Screening Using CALPUFF

Purpose:

To perform CALMET/CALPUFF modeling to address the Best Available Retrofit Technology (BART) modeling requirements in the final EPA BART Rule.

Progress During This Reporting Period:

Technical Activities:

The anticipated RMC role would consist of (1) providing states with MM5 data for CALPUFF modeling and a CALPUFF modeling protocol that can be used by the states or modified as needed; (2) providing assistance to the states in their CALPUFF modeling as needed; and (3) performing regional modeling using CAMx/PSAT and/or CMAQ to examine alternative programs or other aspects of BART. The RMC is working with Tom Moore on the development of the BART modeling protocol.

Preparation of the 2002 Model Performance Report, 2018 Base Case Modeling Report, and 2005-06 Project Report:

None.

Expected Progress During the Next Reporting Period:

During December we will begin processing the MM5 data for CALPUFF modeling and prepare a modeling protocol for BART CALPUFF modeling.

Difficulties Encountered and Resolutions:

None.

Task 7: Sensitivity Studies Designed to Evaluate Uncertainties in Fire Emissions

Purpose:

To perform additional modeling studies to evaluate sensitivity to uncertainty in the fire emissions inventory. Major uncertainties include the effect of the plume rise height for fire emissions, and the effects of small fires in or near Class I areas.

Progress During This Reporting Period:

Technical Activities:

We developed emissions inventories for two months (July and November) for the 12-km CMAQ grid in which we removed all small fires, and we performed CMAQ simulations and compared these results to the base case CMAQ 12-km results. However, we discovered an error in the emissions processing for the fire sensitivity cases. We corrected the emissions and will redo the CMAQ simulations in December.

Preparation of the 2002 Model Performance Report and 2005-06 Project Report:
None.

Expected Progress During the Next Reporting Period:

We will redo the fire sensitivity simulations and comparison to the CMAQ 12-km base case results. These results will be presented at an Attribution of Haze meeting on January 24, 2006.

Difficulties Encountered and Resolutions:

We discovered an error in the processing of the fire sensitivity case emissions. We corrected the emissions and will redo the CMAQ simulations in December.

Task 8. Preliminary Meteorological, Emissions, and Air Quality Modeling Activities for Alaska

Purpose (exact purpose is TBD):

To model point and urban sources in Alaska using a 2002 modeling database based on the MM5, CALMET, and CALPUFF models.

Progress During This Reporting Period:

Technical Activities:

Based on direction given at the April 26-27, 2005, joint meeting of the Tribal Data Development Workgroup and the Emissions Forum on WRAP issues related to Alaska, we began finalizing the Alaska 2002 MM5 modeling report. We also continued with the Alaska CALMET/CALPUFF modeling. Given below is the status of each action item identified during the June 29 conference call described in a previous monthly report:

- Finish Alaska MM5 meteorological modeling report: This report, finished in September, is at http://pah.cert.ucr.edu/aqm/308/docs/alaska/Alaska_MM5_DraftReport_Sept05.pdf.
- Finish Alaska CALPUFF modeling and write report, including chapter on potential Weight of Evidence (WOE) analysis that Alaska can use to project reasonable visibility progress for the visibility SIP: QA of the preliminary CALPUFF modeling identified errors in the emissions. These were corrected and the modeling was revised. The revised results are currently being analyzed.
- Contact Cathy Cahill at University of Alaska Fairbanks on what analysis they have been doing studying arctic haze: We have discussed this issue with Dr. Cahill and she is willing to help however she can. She will assist us in documenting arctic haze, smoke events, Asian dust transport, and other elements we will need for the Alaska WOE visibility SIP.
- Analyze WRAP fire emissions for Alaska and see whether they can be integrated into CALPUFF modeling: Due to limited resources we have shelved this task until additional resources become available.

- Preparation of 2005-06 project report (inclusion of this task in 2002 model performance report and 2018 base case modeling report is TBD): None.

Expected Progress During the Next Reporting Period:

We will continue preparing the Alaska CALPUFF modeling report.

Difficulties Encountered and Resolutions:

None.

Task 9. Further Analysis of Model Performance in Regard to the Contribution of Natural Emissions to Visibility Impairment

Purpose:

To identify the CMAQ “floor” (i.e., the minimum level to which visibility impairment could be reduced by controlling all anthropogenic emissions), and determine whether the base model runs are too “clean.”

Progress During This Reporting Period:

Technical Activities:

None.

Preparation of the 2002 Model Performance Report and 2005-06 Project Report:

None.

Expected Progress During the Next Reporting Period:

In the next two months we anticipate creating a test simulation of a prototype sea salt and surf zone emissions model for adding marine emissions to the WRAP modeling, and beginning development of a prototype model for lighting NO_x emissions estimates. We will also review the natural emissions modeling results from the Section 309 modeling that was completed in 2003.

Difficulties Encountered and Resolutions:

None.

Task 10. Preparation and Reporting of Geographic Source Apportionment Results

Purpose:

To perform additional source apportionment simulations using either the CMAQ Tagged Species Source Apportionment (TSSA) or CAMx PM Source Apportionment Technology (PSAT) models, with the choice to be made based on further evaluation of both models.

Progress During This Reporting Period:

Technical Activities:

We continued to discuss the setup of the source apportionment modeling with the WRAP Modeling Forum and the Attribution of Haze (AoH) workgroup. We participated in an AoH

workgroup meeting in Phoenix, AZ, on November 17. We purchased an additional 4 GB of RAM for one of our Opteron computers to perform additional benchmarks for PSAT with increased numbers of tracers.

Preparation of the 2002 Model Performance Report, 2018 Base Case Modeling Report, and 2005-06 Project Report:

None.

Expected Progress During the Next Reporting Period:

We will perform some model simulations in December to develop run-time benchmarks for CAMx/PSAT; however, we may revise the work plan to perform the annual CAMx/PSAT simulation using the planning scenarios instead of the 2002 version A model performance evaluation scenario.

Difficulties Encountered and Resolutions:

None.

Task 11: Technology Transfer

Purpose:

To transfer the models, model evaluation tools, and data sets to the states and tribes so that they can perform additional studies of emissions reduction strategies, including supporting these groups in model setup and operation.

Progress During This Reporting Period:

Technical Activities:

We replied to several requests for data and information about the visibility modeling.

Preparation of information on the availability of data and tools, to be included in the 2002 Model Performance Report, 2018 Base Case Modeling Report, and 2005-06 Project Report:

None.

Expected Progress During the Next Reporting Period:

We will perform routine updates to the web site, as needed.

Difficulties Encountered and Resolutions:

None.

Task 12: Computer Hardware

Purpose:

To acquire new/additional equipment to support the RMC's work on the above tasks.

Progress During This Reporting Period:

We installed two new RAID5 disk storage systems that have increased our data storage capacity by 8 TB.

Expected Progress During the Next Reporting Period:

None.

Difficulties Encountered and Resolutions:

None.